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Recommended Citation

Suksakulchai, S., & Chunkul, C. (2006). A Real-Time Virtual Classroom System with Two-Way Communication for Distance Learning at King Mongkut's University of Technology Thonburi, Thailand. Retrieved from <https://ro.ecu.edu.au/ceducom/106>

EDU-COM 2006 International Conference. Engagement and Empowerment: New Opportunities for Growth in Higher Education, Edith Cowan University, Perth Western Australia, 22-24 November 2006.
This Conference Proceeding is posted at Research Online.
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Suksakulchai, S. and Chunkul, C. King Mongkut's University of Technology Thonburi Bangkok, Thailand. A Real-Time Virtual Classroom System with Two-Way Communication for Distance Learning at King Mongkut's University of Technology Thonburi, Thailand

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ABSTRACT

Because of high demands for higher education in the provinces of Thailand, the school of Industrial Education and Technology at KMUTT has started off-campus courses since 2002. However, the major problem of operation is distance. To cope with the problem, a real-time virtual classroom system with two-way communication has been developed. The system has to overcome the bandwidth problem, which is the major struggle of web-based learning in Thailand, and to maintain the two-way communication between instructors and students. To cope with those problems, video streaming and live chat systems are used. The technique is the trade-off between two-way and low bandwidth communications. The system consists of video broadcasting, slides, and a live chat system. Instructors give lectures using the video broadcasting and slides, and students can use the live chat system to ask questions. Moreover, the instructor may ask a few questions via the live chat system. The questions are shown on the instructor's screen and stored in the instructor's database. The instructor has a choice to re-explain unclear topics, or to answer the questions after the topics. Students may ask questions or answer to other questions via the live chat system. This project used a PHP programming with MySQL databases for managing the data and databases of the website.

Key words: Virtual Classroom, Two-Way Communication, Real-Time, Video and Audio streaming.

INTRODUCTION

Because of high demands for higher education in the provinces of Thailand, the school of Industrial Education and Technology at King Mongkut's University of Technology Thonburi, KMUTT, has started off-campus courses since 2002. In the current operation, the school uses the traditional method of instructors travelling to classrooms off campus each week. Even though this method has great benefits of face-to-face learning and teaching, it requires high operation costs including lodging, transportation, meals, and any other travel costs. With a new age of technology, it has provided new ways for faculties to reach students such as distance learning both on-line and off-line courses (Deshpande et al. 1999, 2001) using video conferencing (Sankar 1996, Sabri 1985), videotape, CD-ROM, and etc. However, those techniques require high initial costs and are difficult to expand a new off-campus site. To cope with the problems, a real-time virtual classroom system with two-way communication has been developed. The system has to overcome the bandwidth problem, which is the major struggle of web-based learning in Thailand, and to maintain the two-way communication between instructors and students. Therefore, the main purpose of this paper is to find a way for building such system.

Approach

In this research, we propose a system that allows instructors to give lectures using a computer with a camera from their seats and to broadcast them via the Internet to students who attend the lectures from other locations with an ability to communicate to each other. In order to achieve this requirement, the proposed system should have abilities of:

- Two-way communication

- Live lecturing with a virtual whiteboard
- Asynchronous and synchronous learning

In order to make two-way communication possible in practice for real-time virtual environments, we may reduce some features of two-way communication that requires high bandwidths, e.g. two-way video conferencing, two-way voice conversation, and application sharing (Ju Byoung Oh et al. 1997). Only abilities necessary for lectures are used; therefore, tools used by instructors for broadcasting their lectures are video streaming, a virtual whiteboard, and a chat system. On the other side, students will use only the live chat systems to communicate with their instructors, e.g. asking questions, showing their respond, and etc., and a virtual whiteboard to study the lectures.

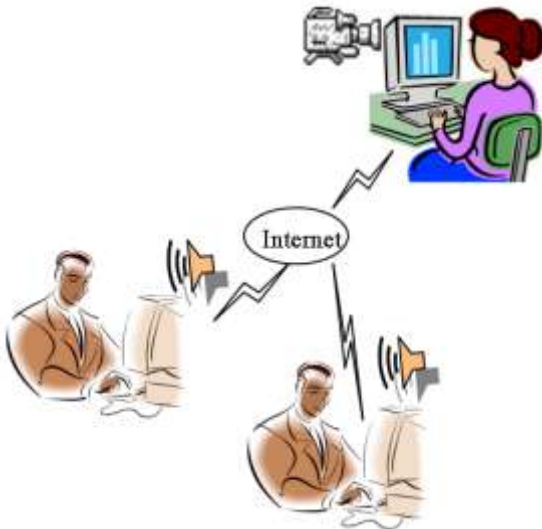


Figure 1: Basic Idea of the proposed system

This technique is a trade-off between two-way and low bandwidth communications in the sense that it maintains the two-way communication between students and instructors, but it uses a lesser amount of communication traffic. Moreover, the live chat system can be used by instructors to ask questions, and students will response to the questions through the live chat system also. Questions asked by students via the live chat system are shown on the instructor's screen and stored in the instructor's database. The instructor has a choice to re-explain unclear topics, or to answer the questions after the topics. Instructors will give lectures using a virtual whiteboard system. Several applications exist for using whiteboards over the Internet e.g. (Zhang 2005, Zhai 2005). However, one problem of using this technique is how to let students who come to the class late can catch up with class just like a normal classroom. In a normal classroom, some students may come to the class late, and, by looking at drawings on the whiteboard, it can give students ideas of what the teacher are currently teaching. This key feature will be discussed in the next section.

Proposed system

One important tool created for this research is a virtual whiteboard, which is used for live lecturing. A virtual whiteboard is a program that acts as a whiteboard used in normal classrooms. One problem of using live broadcasting in synchronous learning is that everybody has to log in to the class before the class begins otherwise they may miss some information given by instructors. Therefore, the virtual whiteboard created must have an ability to redraw each line that instructors already made on the whiteboard, after they log in at a middle of the class. To do so, each stroke of instructor drawing has to be stored for redraw. The virtual whiteboard will redraw all the lines that instructors already drew before students log in and continue to draw what the instructors will draw next. In this way, students will be able to follow the lectures, just like as a normal lecture when students, who come to the class after it already has started, can see what the instructors have written on the whiteboard, and they will be able to follow the lectures from that point. In addition,

the virtual whiteboard is capable of loading all images that instructors have presented, in sequence, to classes during the lectures.

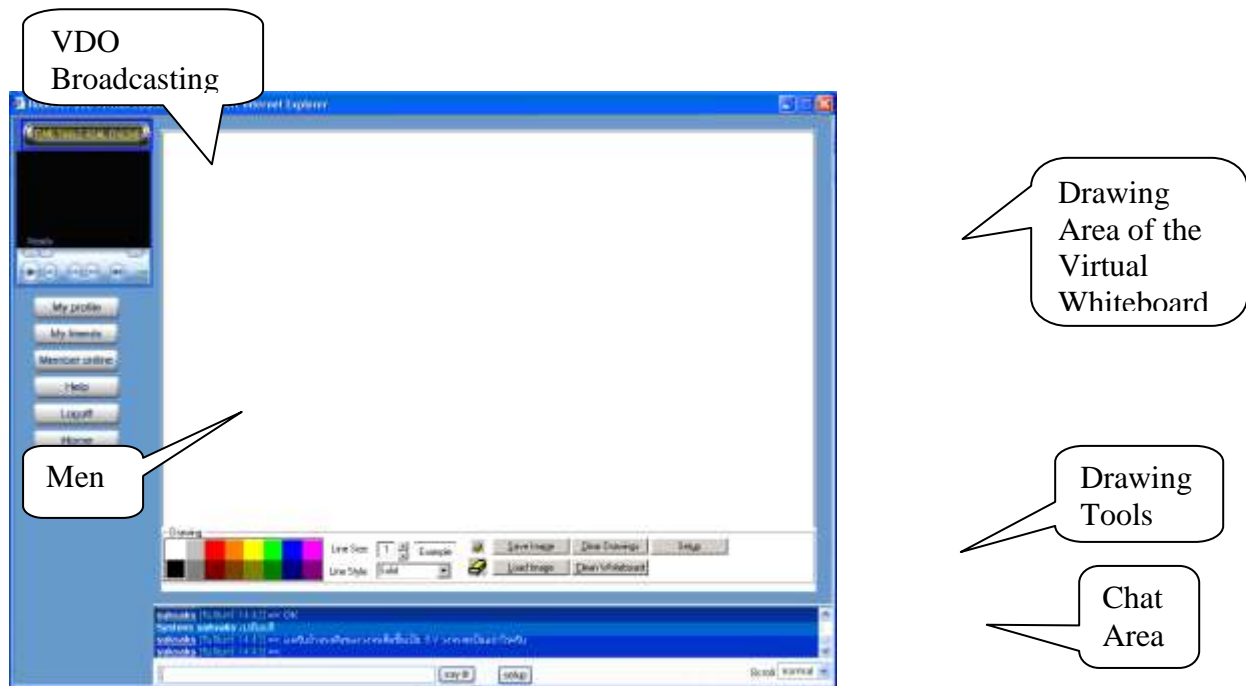


Figure 2: User Interface of the Virtual Whiteboard for Instructors

With this technique, students do not have to log in to the class before the class starts. Each whiteboard screen can be saved for future uses by instructors and students. Moreover, students, who come to (log in) the class late or forget to save their screens, can download the lectures from the server later. Figure 2 shows a screen capture of an instructor's computer. User interfaces of students are similar to the instructor's user interface except for drawing tools that is reserved for the instructor only.

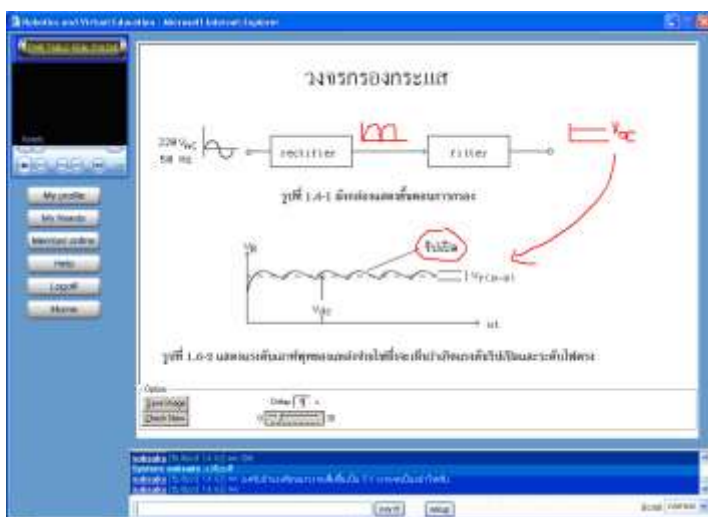
For live video broadcasting, we used a program named Microsoft Media Encoder, which can be used to broadcast both video and/or audio streaming. This work used a PHP programming with MySQL databases for managing the data and databases of the website for the live chat system.

Experimental Results

The experiment setup used one server, used by three instructors, and ten client computers running on the same network and seven client computers running on other network used by seventeen students, currently enrolling in an electronics course. The study was performed at the Electrical Technology Education, School of Industrial Education and Technology, King Mongkut's University of Technology Thonburi. A questionnaire and interview of student satisfaction was used to evaluate the proposed system.



(a) Instructor's Screen



(b) Student's Screen

Figure 3: Comparison between an Instructor's GUI and a Student's GUI



Figure 4: A student attending a lecture of basic circuits

Figure 3 shows snapshots of the instructor and student's computer screens and Figure 4 shows a student listening to his instructor giving a lecture and typing a question to his instructor. As seen from Figure 3(b), there is a delay setting that is used to delay drawing in order to synchronize with the instructor's voice. This is because the drawing was faster than the voice streaming. The setting

was between 5-11 seconds, up to where they were logging on. The result showed that the instructor could give a lecture to her students and they could communicate to each other including asking to the instructor, giving questions, and etc., as normal lectures do.

After the class, students and instructors were asked to evaluate the system and express how they were satisfied with the system as shown in Tables 1 and 2. The good thing, from interviewing, was that students could print given lectures in color and use less writing; therefore they can concentrate on the lectures more.

Table 1: Mean and standard deviation of students' evaluation on the proposed system

Item	\bar{X}	S.D.
1. Display's Layout	4.59	0.51
2. Font Size	4.29	0.59
3. Usability	4.35	0.49
4. Sound	4.24	0.66
5. Video	3.94	0.56
6. Drawing Display	4.65	0.49

From Table 1, it was shown that students were satisfied with the proposed system ($\bar{X} = 3.94$ to 4.65). Their idea was coincident with standard deviation of 0.49 to 0.66.

Table 2: Mean and standard deviation of instructors' evaluation on the proposed system

Item	\bar{X}	S.D.
1. Display's Layout	4.67	0.58
2. Font Size	4.67	0.58
3. Usability	4.67	0.58
4. Sound	4.33	0.58
5. Video	4.00	0.00
6. Drawing Display	4.67	0.58

From Table 2, it was shown that instructors were satisfied with the proposed system ($\bar{X} = 4.00$ to 4.67). Their idea was coincident with standard deviation of 0.00 to 0.58.

CONCLUSION

The proposed system was successfully developed. The system consists of three main parts, the video streaming, live chat system and virtual whiteboard system with ability to record drawing strokes. Instructors used all three parts to give lectures while students used only the live chat system for giving feedback. This technique is a trade-off between two-way and low bandwidth communications. In addition, students do not have to log in to the virtual classroom before the class begins, and therefore, the whole class do not have to wait if one student cannot extend the class on time. In the current state, only the topic currently lectured by the instructor can be redraw line by line. For the future work, this ability may be applied to all drawing images given by instructors.

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